GEOPHYSICAL MODEL OF TIN SKARN AND RELATED DEPOSITS

COX AND SINGER combined models; 14b, tin skarn; 14c, replacement tin; 15b, tin veins; 15c, tin greisens; and tin pegmatites-(no geological model yet)

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Geophysically related models; 20a, porphyry tin; 20b, tin-polymetallic, 25b rhyolitic tin; 39e, placer tin

A. Geologic Setting

- Pegmatite, greisen, vein, skarn, replacement, and fissure lodes developed within or external to specialized leucogranites.
- Generally associated with apical parts of the specialized leucogranites.
- Plutons are generally of S or A type, ilmenite series granitoids (Hosking, 1988)

B. Geologic Environment Definition

Geophysics is used primarily to define permissive areas where leucocratic source granites are present, especially highly differentiated, late stage phases of these source granites.

Magnetic response of parent granitoid weak to non existent, typical of S or A type, ilmenite series granites. Where skarn, replacement, or vein mineralization is present in host rock an irregular magnetic haloe may be present (Bishop and Lewis, 1988; Asanov, 1978; Xianguang, 1988; Webster, 1984a).

Parent granitoid generally shows as a gravity low due to typical 0.1 gm/cm^3 density contrast (Asanov, 1978; Gongjian and Rui, 1988; Bishop and Lewis, 1988).

Radioelement content of parent granitoid is high to very high, giving definition by airborne methods where exposed. High uranium (Yeates and others, 1982) or high thorium (Chatterjee and Muecke, 1980; Towsey and Patterson, 1984) often are keys to enriched parts of pluton.

Electrical techniques are used to map the upper surface of buried plutons to locate apices (Alonso and Corral, 1983; Xianguang, 1988).

Exposed parts of felsic plutons may have distinctive remote sensing signatures, and separate intrusive phases may be identified (Amaral, 1982; Keighley and others, 1980, Guerra, 1978, Moore and Carom, 1983). Covered tin granites have been identified from Landsat data (Marconnet, 1984). Tin granites have been reported confined to areas of relatively shallow depths to the Mohorovicic discontinuity (Gongjian and Rui, 1988), but Zeitz and others (1976) note that in southeast Russia tin is related to a thick crust.

C. Deposit Definition

Geophysical expression is variable, in part due to different deposit types covered. Magnetic and electrical methods are most often applied because of presence of pyrhotite, and accessory sulfides present in ore, giving rise to local magnetic, resistivity and IP anomalies. Locally, elevated Radioelement content may identify favorable structure, especially where late-state alteration has decreased potassium content (Towsey and Patterson, 1984). Gravity may reveal local highs related to metamorphism of surrounding host (Asanov, 1978; Rulski, 1982).

D.

Size and Shape of	**Shape**	**Average Size/Range**
apices of pluton	irregular blister to vertical cylinder	0.25 - 2 km diam.
deposit	variable, irregular tabular	skarn, replacement $2.6 \times 10^6 m^3$ greisen $.3 \times 10^6 - 24 \times 10^6 m^3$ vein $8.9 \times 10^4 m^3$
alteration haloe	donut shape around apices, irregular around deposit	may extend to several kms from pluton

E. Physical Properties (units)	Deposit	Alteration	Source Granitoid	Host
			Leucocratic Granitoid	
1. Density (gm/cm3)	3.9[26]; 2.52-2.84[22] Ao=0.10^3	2.8[26] 2.673	low, 2.6[26]; 2.54-2.68[22] 2.55[3]	*
2. Porosity	variable	variable	variable-low	*
3. Susceptibility S.I.x10^{-3}	variable, low to moderate, 6.43[22]	variable	low, 6-87[22]	*
4. Remanence	?	?	?	*
5. Resistivity (ohm-m)	10's-lOO[26] 2000-6000[3] 17-30K[22]	2000-8000[26]	high-very high 400-1900[26] 26-56K[22]	*
6. IP Effect %	5-12[9] 8-12[3]	moderate	low	*
7. Seismic Velocity (km/sec)	P-2.7-4.1[22] S-1.1-2.6[22]	high?	high P-4.6-6.3[22] S-2.8-4.0[22]	*
e. Radioelements				
K (%)	variable, high or low	?	moderate to high	*
U (ppm)	high?	must be >4[25]	moderate to high	
Th (ppm)	variable, high to low	>6 [7]	moderate to high	
9. Other				
self-potential	moderate to high	?	low-very low	*

F. Remote Sensing Characteristics

Tin-bearing-ore minerals are not spectrally distinctive in the visible and near-infrared parts of the spectrum. Remote sensing expression is based on indirect indicators including spectral, albedo, and textural differences between granitic parent rocks, the contact metamorphic aureole, and the country rocks (James and Moore, 1985; Keighley and others, 1980), vegetation differences between granitic parent rocks and the country rocks (Moore and Carom, 1982), and structural features mappable on various types of images and photos (James and Moore, 1985). Hydroxyl-bearing alteration minerals (clays, micas), iron oxides, and carbonate host rocks can be uniquely identified with high-spectral resolution instruments in the visible and near-infrared (Rowan and others, 1983; Clark and others, 1990), and broad-band data in the visible and near-infrared, such as Landsat Thematic Mapper, are effective for separating the clay-carbonate and iron oxide mineral groups from unaltered, non-iron oxide bearing and non-carbonate parent and country rocks (Knepper, 1989) .

G. Comments

A distinct gravity low, to several 10's of mgal, and magnetic low surrounded by an annular ring of local magnetic highs often is a key to presence of source granite and mineralization in surrounding host. The high resistivities of source granites and metamorphosed host give good penetration by EM methods. AEM methods may be particularly effective in this environment. The Radioelement pattern is apt to be complex due to late stage metasomatism that may produce local K and Th depletion. Passing mention in the literature is made to piezoeiectric methods for tin vein deposits.

H. References

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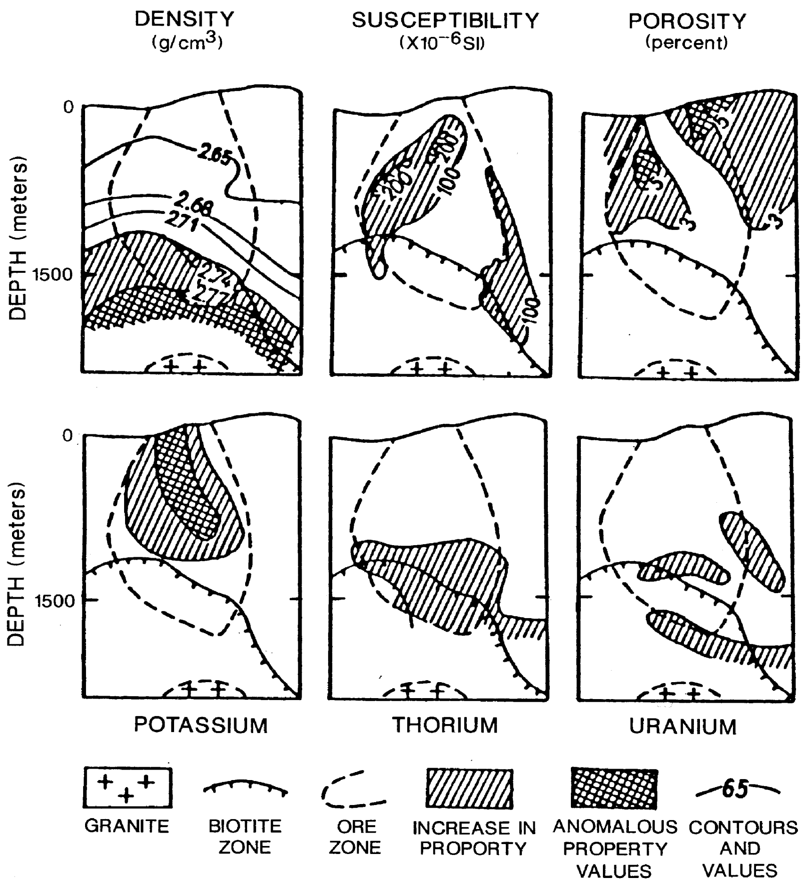

Figure A. Simplified diagram showing distribution of rock density, susceptibility, percent frequency effect (IP), and radioelement content around a tin vein and stockwork deposit. Adapted from Rulski, 1982.

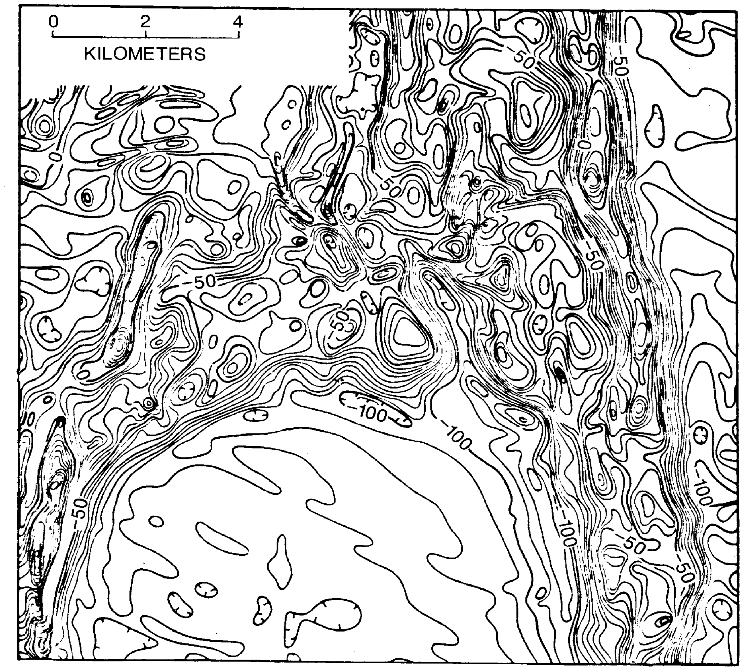

Figure B. Magnetic expression of the Weethalle tin granite and surrounding area, New South Wales, Australia, flown at 85 m above ground and 250 m line spacing. Adapted from Webster, 1984a.